

- 30 -

### Claims

1. An apparatus for the on-line sorting of waste according to its chemical composition and directing said waste into one of two or more channels according to predetermined criterion prior to the introduction of said waste into a waste processing plant or apparatus, wherein said apparatus comprises:
  - a loading unit, adapted to accept said waste from one or more external sources;
  - a weighing unit, adapted for accepting said waste from said loading unit in batches and determining the weight of each of said batches;
  - a detector module, adapted for accepting one of said batches from said weighing unit and determining the presence and amount of one or more specified chemical elements in said batch;
  - a diverter gate, adapted to accept said batch of material from said detector module and to direct said batch into one of said two or more channels; and
  - a controller, adapted to control the activation and the timing of the activation of the elements of said apparatus and to perform calculations and store data necessary for the operation of said apparatus;characterized in that: said waste is not presorted prior to entering said loading unit; said detector module comprises elements for performing a neutron activation analysis technique to determine the presence and

- 31 -

amount of said one or more specified chemical elements in said batch; that the results of said determination is used to decide into which of said channels said batch is to be directed; and said predetermined criteria, is whether the amount of said specified chemical is less than or greater than a predetermined threshold value.

2. An apparatus according to claim 1, wherein the specified chemical element is chlorine.

3. An apparatus according to claim 1, wherein the detector module comprises:

- a neutron moderator casing, made from a suitable hydrogenous material, said casing having an upper and a lower opening that can be selectively opened or sealed by doors;
- an inner chamber whose shape and dimensions are defined by the inner walls of said casing and said upper and lower openings;
- a suitable neutron generator for emitting neutrons to irradiate a batch of waste in said inner chamber; and
- a suitable spectrometric gamma detector for detecting gamma quanta;

wherein, said emitted neutrons interact with different nuclei within said material thus producing excited nuclei, said excited nuclei decay emitting gamma quanta of different energies that are characteristic of

- 32 -

said nuclei, and said detector detects said gamma quanta emitted by said nuclei and measures their intensity as a function of their energy.

4. An apparatus according to claim 3, wherein the suitable hydrogenous material is borated polyethylene.
5. An apparatus according to claim 3, the upper door is pivotally mounted on one end of an arm which has a funnel mounted on its other end, such that, upon rotation of said arm, alternately said upper door either seals the upper opening or said funnel is moved into position to assist in passage of the batches of waste from the weighing unit into said inner chamber.
6. An apparatus according to claim 3, wherein the neutron generator is a portable D-T pulsed neutron generator.
7. An apparatus according to claim 3, wherein the energy of the emitted neutrons is 2.5Mev.
8. An apparatus according to claim 3, wherein the energy of the emitted neutrons is 14.0Mev.

- 33 -

9. An apparatus according to claim 6, wherein the period of time of the pulses are on the order of several seconds.
10. An apparatus according to claim 9, wherein the pulses are emitted for a period of time on the order of 10 seconds.
11. An apparatus according to claim 3, wherein the spectrometric gamma detector is chosen from the group comprising: NaI(Tl) and CsI(Tl) scintillation detectors.
12. A system for processing waste, said system comprising the sorting apparatus of claim 1 and further comprising:
  - a waste processing plant or apparatus;
  - a waste receiving bin, into which waste from a plurality of sources is initially dumped, awaiting transport to said sorting apparatus and eventual processing by a waste processing plant or apparatus; and
  - a suitable transport system for transporting waste from said bin to said sorting apparatus and from said sorting apparatus to said waste processing plant or apparatus or to some other location;wherein said sorting apparatus has three functions: the first function being to divide said waste into substantially equal-volume batches, the second function being to measure the amount of chlorine present in each of said batches, and the third function being to feed each of said batches

- 34 -

of waste into one of two channels according to said measured amount of chlorine and use of said system insures that the amount of chlorine containing compounds introduced into said plant or apparatus for the conversion of waste does not exceed a predetermined value.

13. A system according to claim 12, wherein, if the amount of chlorine in a batch is below a predetermined threshold, the batch is accepted and diverted to the first of the two channels; wherein said batch of waste is transported to the processing plant, to be processed therein in the normal manner.
14. A system according to claim 12, wherein, if the amount of chlorine is above a predetermined threshold, the batch is rejected and diverted to the second of the two channels, to be disposed of in a manner selected from the group comprising the following options:
- option 1, the rejected batches of waste, in said second channel, are stored, and eventually disposed of by not being admitted to the waste processing plant or apparatus;
  - option 2, the rejected batches of waste, in said second channel, are placed in temporary storage, and dealt with at a later time;
  - option 3, the rejected batches of waste in the second channel are returned to the bin, to be re-mixed with other waste, and sent through the sorting apparatus again.

15. A system according to claim 14, wherein the rejected batches of waste, according to option 1, are disposed of at specially designated sites such as municipal solid waste landfills.
16. A system according to claim 14, wherein each of the rejected batches of waste, according to option 2, is assigned an identification number by the control unit, which also contains data regarding the amount of chlorine in each of said batches and the flow rate of waste through the processing plant; whereby, at any given time, the amount of chlorine present in the waste that is being processed by said processing plant is known; additionally suitable sensors at the gas outlet of said plant monitor the gaseous chlorine compounds emitted by said plant and provide this data on a real time basis to said controller; whereby, said controller can then determine whether at any given time, the level of chlorine containing emission is sufficiently low to permit one or more of said rejected batches in the second channel to be introduced into said plant.
17. A system according to claim 16, wherein the rejected batches of waste, according to option 2, are further sorted or arranged on a turntable type arrangement such that the controller can select, access, and dispatch to the processing plant the particular batch that is the most suitable to

- 36 -

maintain the maximum flow rate of chlorine through said plant at any given time.

18. A system according to claim 14, wherein any one or all of the options 1 to 3 are operational at any given time, and the controller may switch from one option to another, according to need.
19. A system according to claim 12, wherein the waste processing plant or apparatus process the waste by using a thermal treatment process.
20. A system according to claim 19, wherein the thermal treatment process comprises the use of one or more plasma torches.
21. A method for operating the system of claim 12 comprising the steps of:
  - dumping waste from a plurality of sources into the waste receiving bin;
  - transporting at least part of said waste from said waste receiving bin to the loading unit of the sorting apparatus;
  - loading at least part of said transported waste into said loading unit;
  - transferring at least part of said waste in said loading unit to the weighing unit;

- 37 -

- stopping transfer of waste into said weighing unit when a predetermined amount of waste, thus forming a batch of waste, has entered said weighing unit;
- transferring said batch of waste to the detector module;
- sealing the doors of said detector module;
- activating the neutron generator to irradiate said batch of waste in said detector module, thus creating excited nuclei in at least some of the molecules of the material of which said batch of waste is comprised;
- activating the gamma detector to measure the quantity and energy of the gamma quanta emitted by said excited nuclei;
- directing said batch through a diverter gate to one of two or more channels; and
- repeating all of the above steps until no more waste remains in said receiving bin or the processing of said waste must be suspended for some other reason;

wherein, the selection of which one of said two or more channels to which said batch is directed is dependent on the results of said measurement of the quantity and energy of said gamma quanta and one of said channels leads directly to the waste processing chamber of the waste processing plant or apparatus and a second of said two or more channels leads to either a temporary storage area, back to said waste receiving bin, or to a



- 38 -

disposal area that is not a part of said waste processing plant or apparatus.

22. A method according to claim 21, wherein a controller is used to control the activation and the timing of the activation of the elements of the system and to perform calculations and store data necessary for the operation of said system.